



تَوِير

BIOLOGY

Lec no :

File Title : Chapter 12 summary

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وَقُلْ رَبِّ زِدْنِي عِلْمًا



cell division role:

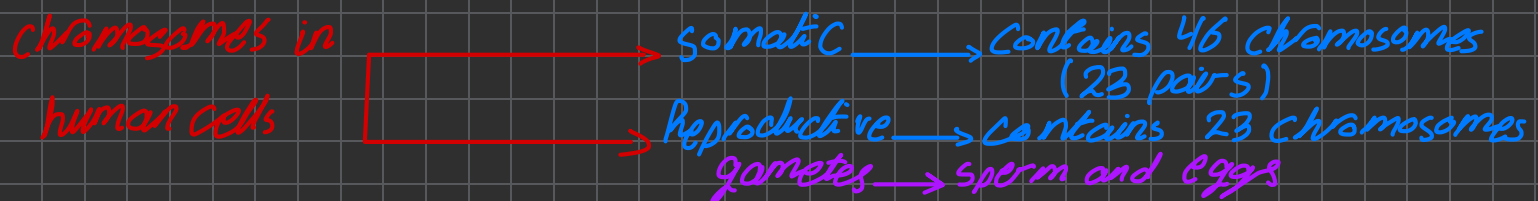
- 1) Asexual reproduction (تكاثر لا جنسي) like amoeba and hydra
- 2) Growth and development like the embryo growth and development
- 3) Tissue repair and renewal like the production of new blood cells from the bone marrow

each chromosome consist of: one long linear DNA molecule with proteins

carry several hundred to a

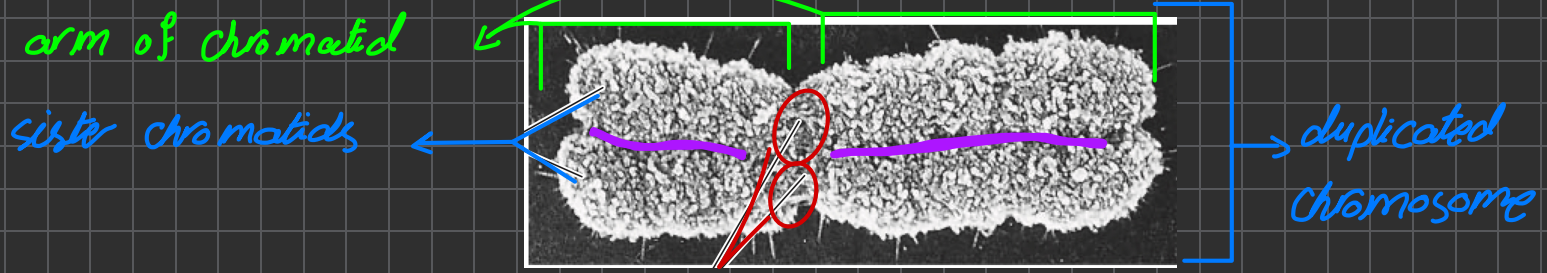
few thousands of genes

has the information of the inherited traits



* chromosome numbers vary for each organism

when the cell is not dividing and not replicating it's DNA the chromosome is in the form of of chromatin (مادة كروماتينية)



centromere: a region of repetitive sequences

(منطقة تتكون من تسلسلات متكررة في DNA) in chromosomal DNA

also the area where the chromatids are closest to each other

cohesin: protein complex that attach the sister chromatids all along their lengths (مركب على طول)

Mitosis and Cytokinesis

division of the genetic material
(chromosomes)

division of the cytoplasm

Reproductive cells are generated by Meiosis

generates 4 cells with half the number of chromosomes found in the parent cell

Example: sperm cells (male gametes) and egg cells (female gametes)

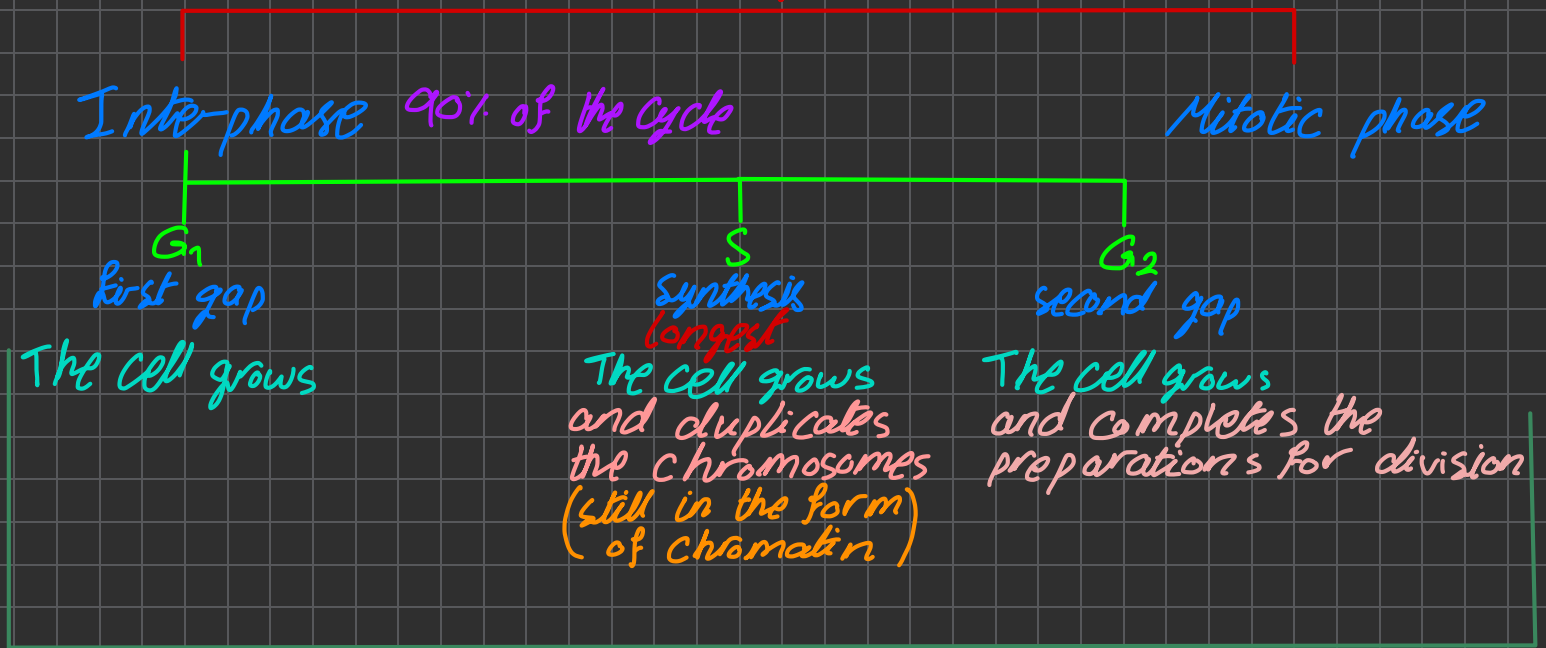
contain 23 chromosomes, while nerve cell (somatic cell)

contain 46 chromosomes

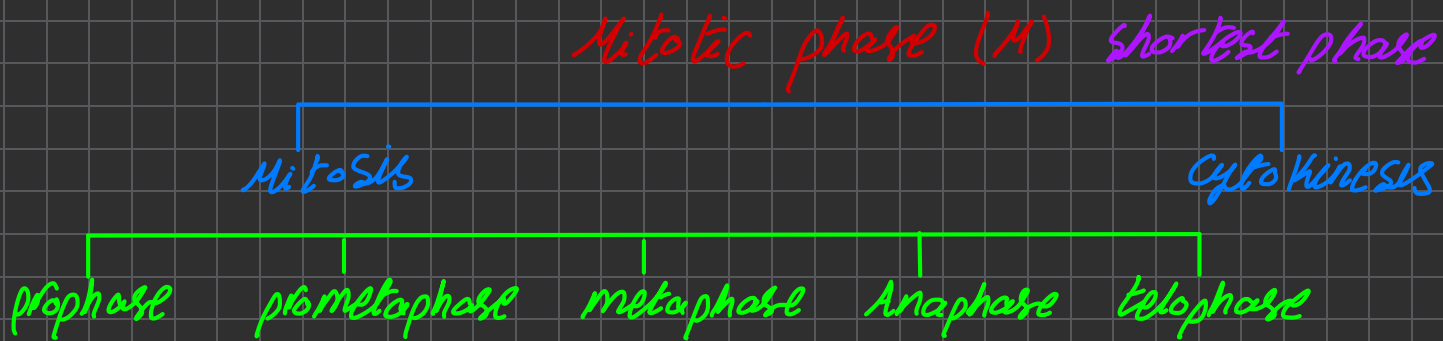
Meiosis in humans occurs only in the gonads

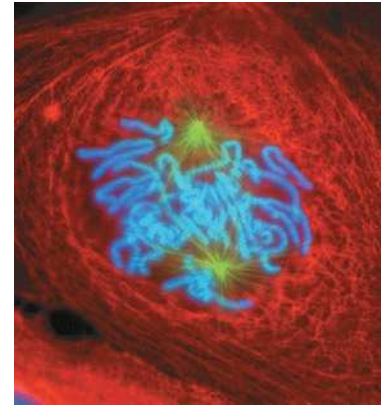
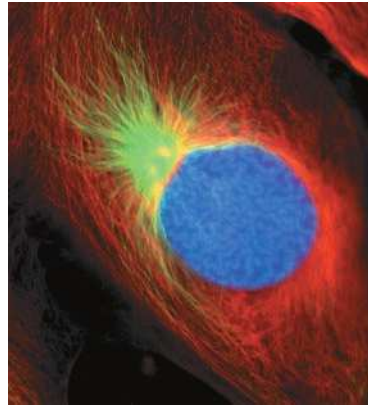
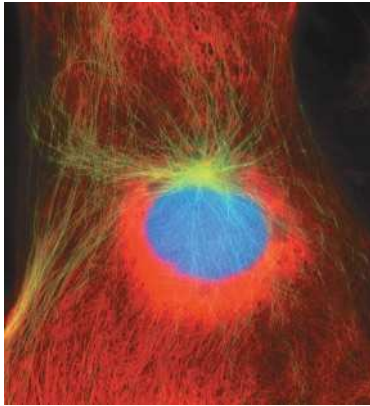
testes ovaries

Cell Cycle



In all of these phases the cell is metabolic active

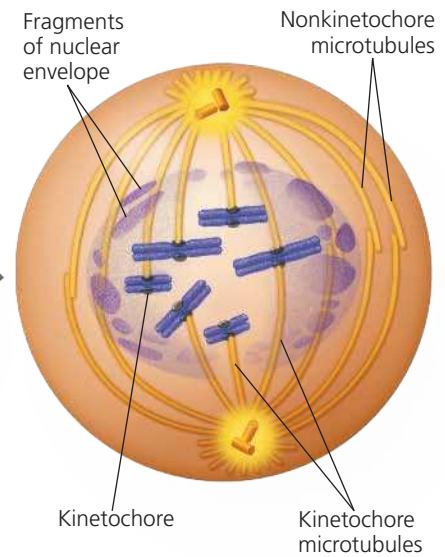
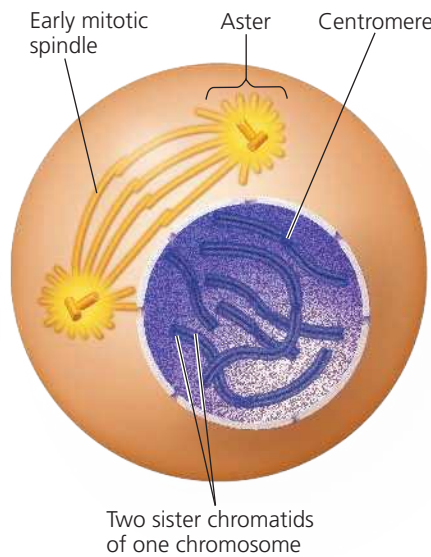
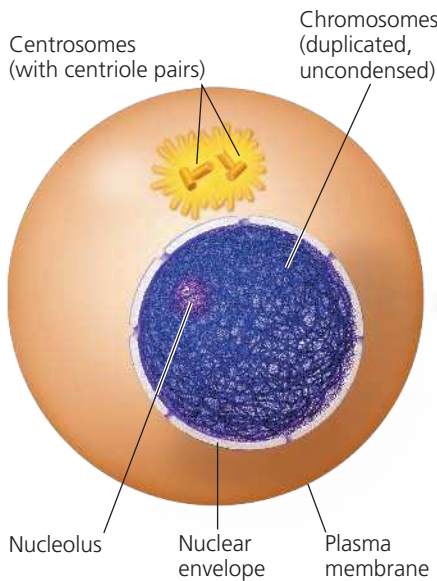




G₂ of Interphase

Prophase

Prometaphase



G₂ of Interphase

Prophase

Prometaphase

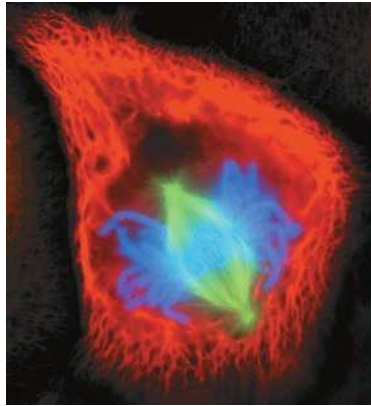
- A nuclear envelope encloses the nucleus.
- The nucleus contains one or more nucleoli (singular, *nucleolus*).
- **Two centrosomes have formed by duplication of a single centrosome.** Centrosomes are regions in animal cells that organize the microtubules of the spindle. Each centrosome contains two centrioles.
- Chromosomes, duplicated during S phase, cannot be seen individually because they have not yet condensed.

The fluorescence micrographs show dividing lung cells from a newt; this species has 22 chromosomes. Chromosomes appear blue, microtubules green, and intermediate filaments red. For simplicity, the drawings show only 6 chromosomes.

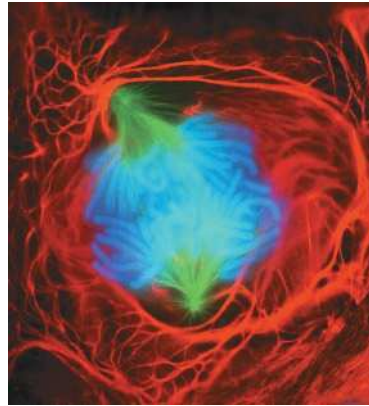
- **The chromatin fibers become more tightly coiled, condensing into discrete chromosomes observable with a light microscope.**
- The nucleoli disappear.
- Each duplicated chromosome appears as two identical sister chromatids joined at their centromeres and, often, all along their arms by cohesins, resulting in sister chromatid cohesion.
- The mitotic spindle (named for its shape) begins to form. It is composed of the centrosomes and the microtubules that extend from them. The radial arrays of shorter microtubules that extend from the centrosomes are called asters (“stars”).
- The centrosomes move away from each other, propelled partly by the lengthening microtubules between them.

- **The nuclear envelope fragments.**
- **The microtubules extending from each centrosome can now invade the nuclear area.**
- The chromosomes have become even more condensed.
- **A kinetochore, a specialized protein structure, has now formed at the centromere of each chromatid (thus, two per chromosome).**
- **Some of the microtubules attach to the kinetochores, becoming “kinetochore microtubules,” which jerk the chromosomes back and forth.**
- **Nonkinetochore microtubules interact with those from the opposite pole of the spindle, lengthening the cell.**

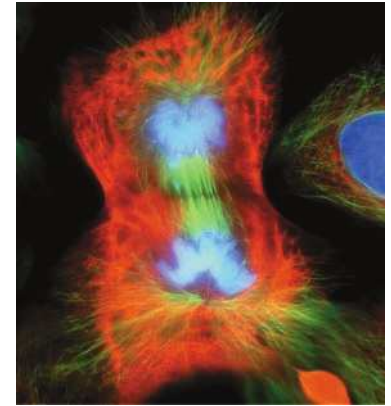
❓ How many molecules of DNA are in the prometaphase drawing? How many molecules per chromosome? How many double helices are there per chromosome? Per chromatid?



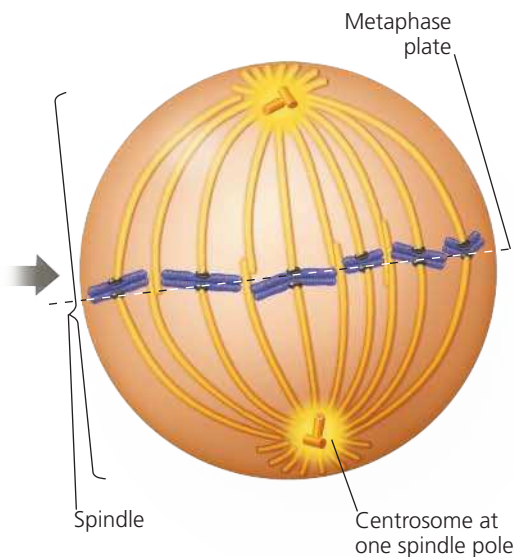
Metaphase



Anaphase

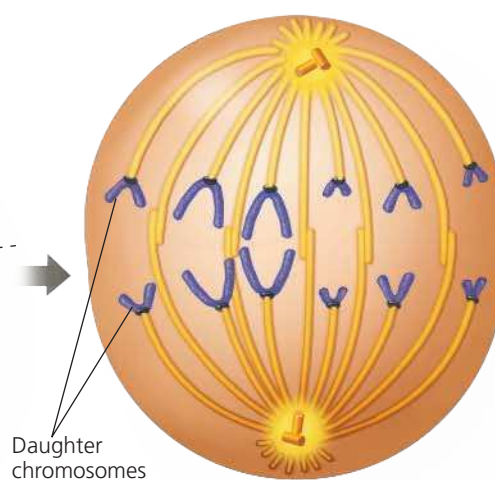


Telophase and Cytokinesis



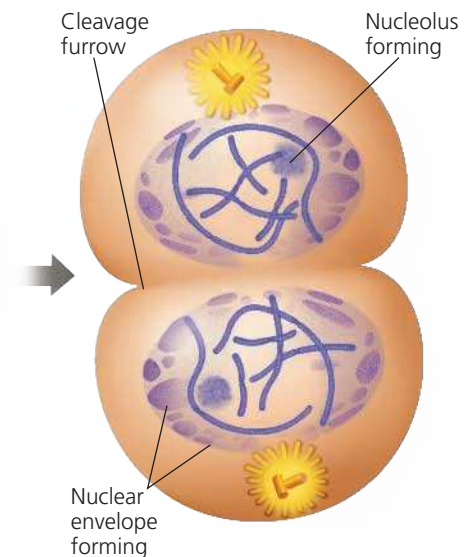
Metaphase

- The centrosomes are now at opposite poles of the cell.
- The chromosomes have all arrived at the *metaphase plate*, a plane that is equidistant between the spindle's two poles. The chromosomes' centromeres lie at the metaphase plate.
- For each chromosome, the kinetochores of the sister chromatids are attached to kinetochore microtubules coming from opposite poles.



Anaphase

- **Anaphase is the shortest stage of mitosis**, often lasting only a few minutes.
- Anaphase begins when the cohesin proteins are cleaved. This allows the two sister chromatids of each pair to part suddenly. Each chromatid thus becomes an independent chromosome.
- The two new daughter chromosomes begin moving toward opposite ends of the cell as their kinetochore microtubules shorten. Because these microtubules are attached at the centromere region, the centromeres are pulled ahead of the arms, moving at a rate of about 1 μm/min.
- The cell elongates as the nonkinetochore microtubules lengthen.
- By the end of anaphase, the two ends of the cell have identical—and complete—collections of chromosomes.



Telophase

- Two daughter nuclei form in the cell. Nuclear envelopes arise from the fragments of the parent cell's nuclear envelope and other portions of the endomembrane system.
- Nucleoli reappear.
- The chromosomes become less condensed.
- Any remaining spindle microtubules are depolymerized.
- **Mitosis, the division of one nucleus into two genetically identical nuclei, is now complete.**

Cytokinesis

- The division of the cytoplasm is usually well under way by late telophase, so the two daughter cells appear shortly after the end of mitosis.
- In animal cells, cytokinesis involves the formation of a cleavage furrow, which pinches the cell in two.

➔ Mastering Biology BioFlix® Animation: Mitosis
Video: Animal Mitosis (time-lapse)

The Mitotic spindle

Kinetochores: A structure made of proteins that have assembled at the centromeres (two kinetochores per chromosome, one on each chromatid)

components of the spindle:

- 1) The centrosomes
- 2) The spindle microtubules (they form in prophase and prometaphase)
- 3) The Asters: short microtubules that extend from the centrosome and contact with the plasma membrane

A) **Kinetochores microtubules**: they attach with the kinetochore on the chromosomes and they start to pull the chromosomes toward the pole they extended from **until** the kinetochores microtubules from the opposite pole attach to the other kinetochores on the same chromosome when this happens the chromosomes go back and forth (see 2.3) then it settles in the middle of the cell (metaphase plate)

Imaginary plate that is in the middle of the cell, where the centromeres of chromosomes sit at in metaphase

B) **Non-kinetochore microtubules**: the microtubules that don't attach to the kinetochore on the chromosomes, they elongate and overlap to interact with the other microtubules from the opposite pole and they help with the lengthening of the cell

Anaphase begins when the cohesin holding the two sister chromatids is cleaved by an enzyme called **separase**

Cytokinesis: The division of the cytoplasm

In animal cells: by a process called cleavage

a cleavage furrow appears near the site of the metaphase plate (middle of the cell), on the cytoplasmic side (inside the cell) there is a contractile ring from actin microfilaments with myosin protein and the ring keeps on contracting until the cell is separated into two cells

In plant cells: There isn't a furrow because of the cell wall so in telophase vesicles from Golgi apparatus move to the middle of the cell where they coalesce and produce a cell plate, and the cell wall materials are collected there, the cell plate enlarges until the membrane surrounding it fuses with the plasma membrane

CDKs

Cyclin-dependent kinases
enzymes that activate
or inactivate proteins
by phosphorylating them

and it stays inactive
in the cell after the
degradation of the cyclin
it needs to be attached
to a cyclin to be active

+ Cyclins

A protein that get the
name from its cyclically
fluctuating concentration
in the cell

synthesised in late S phase
and it accumulate in the
cell because it is protected
from degradation, then it
combines with CDKs in G₂
producing MPF, it gets
degraded in anaphase
till G₁ phase

= MPF

maturation promoting factor
or
M-phase-promoting factor
named like this because
it is needed by the cell
to enter M-phase

it works directly as
a kinase and indirect
by activating other

Kinases
Example:

it cause phosphorylation
of various proteins of
nuclear lamina which
promotes the

fragmentation of the
nuclear envelope in
prometaphase

checkpoints: control points where stop and go-ahead signal control the cycle

G_1 most important, S stops the cell cycle if there is DNA damage, G_2 , M doesn't let the cell start anaphase until all kinetochores of the chromosomes are attached with the spindle

a checkpoint between anaphase and telophase

make sure that anaphase is completed and that all the chromosomes are separated

Growth factor: a protein released by one cell that stimulates another cell to divide

like: platelet-derived growth factor (PDGF), made by blood cell fragments called platelets, and it is released when you get injured, it is required for the division of Fibroblasts

a type of connective tissue that has receptors for PDGF which send signals to the cell to pass G_1 checkpoint and divide